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ON THE CLASSIFICATION OF CILIATE INFUSORIA.

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AFTER so eminent a naturalist as Bütschli has modified Stein's system of Ciliata, it may appear rather assuming if I venture to propose some changes. It is done because my views have long been held, and have been confirmed as the years passed.

In the first place, it seems that the Peritricha are of an organization quite different from that of all other ciliates. The formation of the anterior part, peristome, mouth, etc., is unique, although having some resemblance to that of the Stentorina. There is no adoral zone with transverse rows of cilia like that in Heterotricha and Hypotricha, as has recently again been asserted by Delage et Herouard.¹ The arrangement of the muscular elements in the ectoplasm, or myonems, is quite different. The formation of a temporary posterior girdle of cilia for locomotion, in the most typical Peritricha, and even the permanent one in some others, is a very distinguishing feature. And a distinction of highest order is their mode of fission in the longitudinal axis,² or by gemmation. This character has been explained in various ways, and some have tried to bring it in conformity with the transverse fission in the other groups. Nevertheless, it remains different, and shows, combined with the other features noted above, that this group is of quite another type, or phylum, the more so if we add the peculiar phenomena of conjugation. The remaining Ciliata differ from the Peritricha in regard to these characters, and they resemble one another in respect to the most significant of them.

¹ *Traité de Zoologie Concrète. I. La Cellule et les Protozoaires.* Paris, 1896, p. 452.

² It must be noted, however, that in all groups the direction of the division is across that of the myonems.

In opposition to the Peritricha, we may give to this second group the name Pantotricha. Among the latter, those forms having a true adoral zone with a distinct beginning and end at the mouth entrance, and bearing transverse rows of single cilia, that is, the Hypotricha and most of the Heterotricha, evidently are of a common type, and range in one group, which I propose to name Zonotricha. True, the extreme forms are very different, *e.g.*, a Stentor on the one hand, and a Stylonychia or Euplotes on the other. But it is well known that both series, by gradual changes, in fact, run together, and that there are forms which may be ranged with one or the other. Many Peritricha are quite depressed, while there are Oxytrichidæ nearly terete, showing little differentiation of the dorsal and ventral faces, with fine and densely set cilia over most of the body (Strongylidium). And such forms as Stichospira¹ make the distinction still more illusory. Tactile hairs (or "dorsal cilia") are wanting in some of the Oxytrichidæ as well as in Euplotidæ and Aspidiscidæ. Longitudinal differentiation in the ectoplasm of Urostyla, etc., comes very near the myonems in Peritricha. With the Zonotricha range Halteria, probably also Strombidium and Gyrocoris. A rather aberrant group, falling under the same head, are the Ophryoscolecidæ, with their retractile peristome.

After removing these forms, the Oligotricha, *i.e.*, mainly the Tintinnidina, make a more uniform small group, characterized by the circular uninterrupted zone bearing cilia of a different form and type, inside of which the mouth is situated.

The Gymnostomata have been made by Bütschli a group of highest order, equal in value with all the other groups combined. It has been shown above that in a number of essential features they differ from the Peritricha and are in harmony with the other Pantotricha, and they are especially so with the Aspirotricha. Yet the formation of the mouth, together with some other characters, is so significant that it does not seem natural to reunite these two groups into the old order Holotrichida, as the French authors have done (*loc. cit.*, pp. 430, 452).

¹ See the writer's article, this journal, vol. xxxi, No. 366, June, 1897, pp. 535-541.

In the great diversity of the formation of the body among the Gymnostomata we have an interesting analogue with an equally wide range among the Zonotricha.

The highest position must be assigned the Oxytrichidæ and Euplotidæ. Here the differentiation of the main feature of the ciliates, the cilia, reaches its maximum, not only morphologically, but also physiologically, combined with the highest development of intellectual faculties, as far as we dare speak of such. In all these points the Peritricha, which have often been placed at the head of the class, are inferior. And their inferiority is demonstrated also by the fact that at least half of them are epizoa, or commensals; a large number of animals of both categories live in colonies, either actually coherent or close together, modes of life which are not so much different as is commonly supposed.

The groups Peritricha,¹ Gymnostomata, Aspirotricha, Oligotricha, and Zonotricha seem to have the significance of orders of about equal standing with "orders" throughout the animal kingdom. Thus we would have the following table :

SUBCLASSES	SUPERORDERS	ORDERS
<div> <div> <div>Peritricha</div> <div>Pantotricha</div> </div> </div>	Gymnostomata	Peritricha
	Trichostomata (em.)	Gymnostomata
		Aspirotricha
		Oligotricha (em.)
		Zonotricha

The Ciliata here are regarded as a class. To this point, a little digression may be excused. Why should not both Ciliata and Suctoria be treated as classes? Conceded that Bütschli is right in regarding the tentacles as mouths, and I believe so, that would not necessitate ranging them together. The possession of cilia by the Acinetina, in the early stages of development, has possibly been overestimated. How many features are shown, in the earlier or larval stages of other and higher animals, to disappear at a later period, *e.g.*, cilia in Mollusca (velum) and Echinodermata? If an amoeboid stage, or the development and disappearance of flagella, were accorded so

¹ The Peritricha might probably be divided into two orders; but, since I have not seen Licnophora and Kentrochona, the question is left open here.

much significance, how should we then, with good reasons, regard the Rhizopoda, Sporozoa, and Flagellata as so many classes? The close resemblance of the phenomena of conjugation in the Ciliata and Suctoria are certainly significant ; but we have essentially identical ways of fecundation, etc., of the ova in different main groups of Metazoa. In their definite formations the Ciliata and Suctoria are as much different from each other, or much more so, than, for example, the classes of vertebrates and arthropods. The question seems to be rather one of logic : if the Suctoria, in their definite stage, are to be considered a degenerated type of Ciliata, they must be ranged under the same head, as a subgroup ; if not so, they may well rank as a class at the side of the Ciliata.

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